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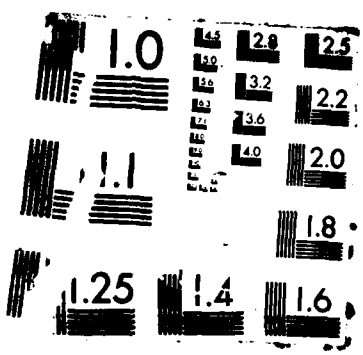
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AGARD ADVISORY REPORT No.256

Technical Evaluation Report on Efficient Conduct of Individual Flights and Air Traffic or Optimum Utilization of Modern Technology for the Overall Benefit of Civil and Military Airspace Users

NORTH ATLANTIC TREATY ORGANIZATION

ADVISORY GROUP FOR AEROSPACE RESEARCH AND DEVELOPMENT

(ORGANISATION DU TRAITE DE L'ATLANTIQUE NORD)

AGARD Advisory Report No.236

TECHNICAL EVALUATION REPORT

on

EFFICIENT CONDUCT OF INDIVIDUAL FLIGHTS AND AIR TRAFFIC

or

OPTIMUM UTILIZATION OF MODERN TECHNOLOGY

FOR THE OVERALL BENEFIT OF CIVIL AND MILITARY AIRSPACE USERS

by

Dr Ing. Bernardo Furcolo
Radar and Systems Division
Selenia
00131, Roma
Italy

This Advisory Report was prepared at the request of the Guidance and Control Panel of AGARD.

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- Improving the co-operation among member nations in aerospace research and development;
- Providing scientific and technical advice and assistance to the Military Committee in the field of aerospace research and development (with particular regard to its military application);
- Rendering scientific and technical assistance, as requested, to other NATO bodies and to member nations in connection with research and development problems in the aerospace field;
- Providing assistance to member nations for the purpose of increasing their scientific and technical potential;
- Recommending effective ways for the member nations to use their research and development capabilities for the common benefit of the NATO community.

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TECHNICAL EVALUATION REPORT

by

Dr. Ing. Bernardo Furcolo
Radar and Systems Division, Selenia
Rome, Italy

FOREWORD

The 42nd Symposium of the Guidance and Control Panel of AGARD was held at the Belgian Air Force Headquarters, Brussels from the 10th to 13th June, 1986.

The Programme Chairman was Dr. A. Benoit of European Organization for the Safety of Air Navigation, EUROCONTROL. The Programme Committee also included:

- Dr. M. Pelegrin FR
- Dr. H. Sorg GE
- Prof. P. Murino IT
- Mr. J.L. Hollington UK
- Prof. W.M. Hollister US

The meeting was attended by more than 150 representatives of NATO.

THEME AND OBJECTIVES

In recent years an appreciable effort has been made to improve the conduct of individual flights, the control of air traffic and the management of traffic flow, with the objective of increasing the level of safety. This report summarizes and evaluates presentations given at a symposium held in Brussels in June 1986 (p. 10)

The following statement given in the meeting announcement outlines the theme and objectives.

"In view of present valuable developments in guidance control, navigation, communications, surveillance and particularly processing facilities, it is essential to revise the conduct of flight and control of air traffic, placing the emphasis on the integration of the many different components involved. Within this context the symposium will intend to cover: a) the integration of various (civil/military) user's requirements (economy, capacity, integrity, security) depending on areas (open/restricted) and the time of periods (peace time, military training, strategic operations, battlefield) and b) the integration of control phases to achieve overall economy in peace time or increase probability of achievement of missions for military aircraft (training of battlefield) in periods of conflict.

The introduction of recent technology should improve the control of individual aircraft trajectories and lead to enhanced conduct of air traffic. Nevertheless because of the multiple international aspects of ATC, long delays must be reckoned with before new regulations are implemented. Accordingly it is time to prepare for the future by examining the possibilities offered by new technologies, in particular the use of powerful data processing facilities, the introduction of satellites for integrated navigation communications and surveillance and the potential role of automatic two-way air/ground data links, advanced surveillance radar, advanced landing systems, the management of air traffic (particularly in extended terminal areas), the potential and limitations of automation, including the possible applications of intelligent knowledge, and the on-board equipment clearly necessitating a new look at the relation between air traffic control and individual aircraft".

TECHNICAL CONTENT AND EVALUATION

The meeting opened with a welcoming address by Prof. Onken, the Guidance and Control Panel Chairman, who also described the programme.

Then Dr. Benoit explained the theme that would be adopted for the symposium.

Lastly Mr Vandenbroucke, Director of the Dept. of Belgian Air Traffic Safety, gave the keynote address with a brief description of the CANAC project which will update the modernization program for the processing and display of radar and flight data.

SESSION I – LOOKING TO THE FUTURE

Carel (11) described the terms of reference of the FANS (Future Air Navigation System) Special Committee of ICAO with ongoing work on CNS as communication, navigation and surveillance.

A general overview of satellite technology was given both for air/ground communications and ADS systems (Automatic Dependent Surveillance), whereby an aircraft periodically, or upon ATC request, transmits on-board derived data (identity, flight level, meteo information, etc.) to the ground system.

Porisky (12) also concentrated on the future use of satellite systems and the U.S. perspective of replacement of existing ATC facilities.

The following aspects were highlighted:

- Technologies are rapidly advancing for which it will be essential needs.
- Generally the requirements for a new system are based on the investment capability, nevertheless the benefits must compensate the related cost.
- Communication, navigation and surveillance will develop the satellite system for civil users. For the future it will be essential to study the integration of satellite technologies with ground based services.
- In the communication field it will be important to establish a minimum system standardization.

Lastly Vachiery (13) explained the highlights of the future improvements to the ATC services.

Actually the management of traffic flow is based only on the ground capability and the consequent limitations will affect the standard minimum separation whilst the avionic system has a more comprehensive flight management system (FMS).

However, some difficulties have to be taken into account:

- international agreements
- human factors
- airspace organization

The developing areas are identified as:

- accurate navigation
- accurate position-finding (istantaneous and forecasted)
- automatic air/ground communication

In conclusion the suggestions for further studies are: the harmonization of tactical and strategical air management by using a data link and expert systems.

SESSION II (a) – GLOBAL POSITIONING SYSTEM

This session brought an interesting set of papers illustrating the GPS technique that in the near future will become a navigational aid in the military area as well as the civilian field.

The first one by Hartl (21) gave a deep panorama of the characteristics and performance of GPS, the measurements accuracy and finally the comparison with the other types of navigational aids.

The second paper by Lloret (22) reviewed some recent advances relating to the use of the inertial system with a GPS. Besides the advantages of the integration, the results in the experimental phase, the cost-effectiveness aspect, the military application program in the next future are detailed.

The last paper by Lowenstein (23) gave a description of an useful application of GPS as a navigation system for the U.S. Navy aircraft as a substitute for the traditional system and with RNAV capability.

During the discussion session many questions were raised concerning GPS outages and coverage requirements in the civilian field, where the application will relate to the en route and non-precision approach phase.

SESSION II (b) – AUTOMATIC AIR/GROUND/AIR DATA LINK

The first paper (Elliott replaced Pickens) (24) showed the various facets of the communication satellite based system.

He indicated the technique for arriving at the optimization of the data transmission between aircraft and satellites.

Cox (25) gave a brief description of the Mode S Data Link characteristics as message fields, communication protocol and link capability.

Later an overview on the pilot/controller link interface was given, based on experimental work by EUROCONTROL.

The work utilized an aircraft simulation with a display presenting messages fo-

navigation, clearances and other purposes (ground data bank, VOLMET and ATIS information, etc.).

Furthermore for the controller link the data exploited for ATC purposes relate to tracker and meteo indication, providing better tracking accuracy and precise trajectory prediction respectively.

An important aspect is the future development program which will include ground station and networks, on-board equipment and finally the evaluation activities on surveillance, link performances, ground communications and data link applications.

SESSION III – ADVANCED SURVEILLANCE RADARS

The first paper by Galati (31) described a typical system architecture with a proposal for further relevant studies.

The technical highlights, which were also the subject of discussions were:

a) Space-based surveillance systems to exploit the advantages of:

   - unlimited line of sight
   - large area coverage (as both in the USA and the USSR large access functions are being considered).

b) A constellation of low orbit satellites, carrying primary and secondary radars, can be devised to satisfy both civilian and military requirements for the period 1995-2000 onwards.

c) The system structure can be tailored to European needs and could be developed in ten years by a joint effort.

d) The space-based system is not necessarily a replacement for the Automatic Dependent Surveillance (ADS), instead these two concepts can usefully complement one another.

This paper is important in view of:

- the new concept of a multi-users and multi-function system;
- the envisaged application to the European environment and analysis of relevant studies.

Promising results have been obtained and further work has been proposed on the basis of international cooperation, in the fields of techniques, system architecture, components technology, and system reliability.

The next two papers described the realization and characteristics of the Monopulse Secondary Radar and MTD Primary Radar, both developed by Thomson-CSF.

Delille (32) after a review of the Mode S System, gave a complete description of the antenna transmitter, receiver and processing technique of the Monopulse SSR, maintaining compatibility with Mode S.

The second paper by Bruno (33) explained a Moving Target Detector radar (MTD) with a separate weather channel.

Programmable modular processors are used for the digital signal processing and data processing. The algorithms include an 8-Doppler filter bank, a CFAR thresholding, an adaptive clutter map and an algorithm for estimating the radial velocity.

The weather channel produces, with 16 range gates, the intensity of precipitation within the radar coverage.

Finally the experimental results were given for Primary and Monopulse radar and obtained in collaboration with the French administration.

SESSION IV – ADVANCED LANDING SYSTEMS

In the absence of the author (Remer) Billmann (41) reported on the MLS application in the Airport terminal area, based on the capability to navigate and execute approaches (RNAV).

Prior to practical implementation of RNAV System analytical studies were conducted at the FAA Technical Center, for the testing of algorithms for position definition, resulting from offset approaches.

A simulation was conducted using live flight data.

Seifer (42) described work which is being developed to solve the technical and operational problems of implementing the MLS.

The highlights were:

- MLS procedures: segmented and curved approach paths.
- Automation of ATC systems: data base of standard paths, algorithms to compute free approach slot for the aircraft and time/position.
- Automation in the aircraft system: data base containing the standard approach routes, algorithms to compute paths and time, which are based on the data transmitted from MLS.
- Data link capability between air and ground.
- Cockpit automation and MLS approach information: appropriate display for planning and navigation aid (horizontal and vertical attitudes).

SESSION V – AIR TRAFFIC MANAGEMENT – AUTOMATION – ADVANCED TMA

This session produced a set of papers illustrating a variety of works.

Research has been active in this area for several years.

The first two papers described the efforts underway within NASA and FAA programs to provide a technological basis for reducing delay and improve aircraft efficiency at major terminals.

The time-based traffic control concept is proposed by Howell (43), which should integrate ATC/aircraft on the basis of interaction, flexible fuel efficient trajectory and automated controller aids.

The major steps in the proposed time-based flow control research study are as follows:

- aircraft landing sequence and spacing
- time of arrival and ground expected trajectory
- automated assistance to controller.

A ground based simulation program is used in conjunction with computer simulated aircraft.

The second paper by Erzberger (52) also dealt with an automated air-traffic management concept, giving a detailed review of the scheduler, which assigns conflict free landing time, and of profile descent trajectory.

The advantage of system is that it provides an automated flow control for all types of aircraft.

Of particular note is that the scheduler is designed as a real-time expert system.

Murino substituting Bianco (51) described a strategic control concept based on a multilevel model of distinct sub-functions, divided into off-line and on-line controls.

A mathematical formulation is defined and the algorithms relative to the altitude and speed control have been simulated on a computer. Generally a different series of tests should be performed in order to solve the problem of optimization.

Porisky, substituting Hunt and Page (53), described the U.S. efforts to support the development of the ATC services considering the definition of new systems and approaches. In order to overcome the current system limitations (i.e. productivity, capacity, reliability, logistics) a program strategy is being developed:

- install new host computer systems at the en route centers
- introduce new sector suite to increase controller capability
- provide a new software and functions (AERA).

Some ensuing remarks should be emphasized:

- the enhancement program requires a large economic investment
- the development phase is slow
- necessity to gather controllers, pilots, avionics and ATC Industries.

The next two papers described the design and realization of a system for air traffic management in the extended terminal area, also known as a zone of Convergence including the main terminal manoeuvring area.

Volckers (54) explained the main functions and preliminary results of the experiments for the COMPAS system developed at the DFVLR - Institute for Flight Guidance with BFS (German ATC Authority) cooperation using traffic scenarios of Frankfurt airport.

The operational objectives are to achieve the best usage of runway landing capacity, by applying, whenever possible, economic approach profiles.

The computer procedures suggest an arrival sequence and schedule and then advise the controllers to execute a set of planned functions.

The program input parameters, which anticipate up to 30 minutes, are radar position, flight plan data, aircraft performance and airspace organization. The controller will then be provided with planning results as an aid to the decision making.

Swierstra (55) outlined the management of Air Traffic over an extended terminal area and the operational procedures to conduct each individual flight throughout this area, in accordance with pilot and controller functions.

The system, developed by EUROCONTROL, generates the sequence of arrival times (ROSAS) and provides control directives for each individual inbound trajectory (CINTIA).

A principal feature of this system are the 4-D trajectories defined to optimize the economy/expedition and capacity, whilst the estimated time is accurate to within 10 seconds for flight paths (from entry to touchdown) up to 200 NM.

The management component assigns a landing slot to the aircraft entering the area, according to controller responsibility.

Control directives are generated by computer, displayed on the radar screen and later translated into standard technical instructions (which in future will be via an automated digital link between the ground and air).

At the moment aircraft operations are simulated using current airline simulators operated by professional crews, to investigate in terms of time accuracy, man-machine interface and the economic impact.

An useful demonstration was held by Dr. Benoit at Brussels airport, in cooperation with Belgian ATC authorities, using the SABENA DC-10 flight simulators.

SESSION VI – FLIGHT MANAGEMENT AND OTHER ON-BOARD SYSTEMS

This session gave an interesting overview of the current level of avionic sophistication with respect to the progress made and the proposal for ATC integration.

Meredith (61) described the flight management function designed to enhance the airport capability.

The computing characteristics of position determination, flight plan construction and prediction provide the ATC ground based system with the information that it needs to perform the planning function. For this task it will be essential to develop a data link capability.

Friedman (62) described his work for improving the fuel efficiency of Navy aircraft based on an integrated Flight Performance Advisory System, which provides a display to the aircrew of the flight parameters (such as altitude and airspeed) necessary to optimize the flight economy.

Schanzer (64) gave a description of a multiloop flight control system used to achieve accurate flight path guidance and safe and economic control of aerodynamic performances.

The flight test results were given for an experimental digital system.

Lastly England (65) gave a detailed review of the activities at the Royal Aircraft Establishment in the fields of navigation (DME Operations), flight management (time control) and display (navigation data).

Future trends that should be noted are:

- navigation: position fixing accuracy
- flight management and display: man-machine interface and atmospheric data handling.

SESSION VII – CONTRIBUTION TO SYSTEM AUTOMATION

The last session opened with a description by Ratcliffe (72) of a computer program "check word" used to detect the differences between two or more versions of a given message.

Nicol (73) then provided a guideline concept for the introduction of Intelligent Knowledge Based Systems to the ATC.

The necessity to change the existing system structure (i.e. in terms of traffic growth airport capacity, cost, safety, etc.) was emphasized, nevertheless the role of complete automation showed the limitations caused by controller activities.

Expert systems contain rules and concepts used by specialists when they select a decision based upon experience. In this way expert systems exploit a new appropriate relationship between controller and computer which therefore includes knowledge into the program.

Finally, Air Traffic Flow Management, Conflict Resolution and Training should be the focus of further study.

ROUND TABLE DISCUSSIONS

The Program Chairman with the delegates herewith listed summarised the highlights of the meeting thus:

- Satellite system — Carel
- Role of automation — Holcomb
- Traffic management in terminal area — Howell
- New technology — Maignan
- Human resources — Hopkin
- Future systems — Vachiery

A lively interesting discussion followed. The essential interventions are summarized in the Proceedings of the meeting, but it is neverthless worthwile to note the main conclusions.

- Airline manufacturers, ATC controllers, pilots and designers closely coupled to achieve minimum cost in the integration phase;
- Need to improve simulation in the ATC environments, in order to take account of aircraft/avionics development;
- Management of traffic as algorithms and 4-Dimensional trajectories in extended terminal area with the goal of saving cost, time and fuel and achieving maximum use of available capacity;
- The use of computers with expert systems;
- The role of the controller in the future system: the design of adequate interfaces should be considered carefully;
- System analysis of space-based radar for both the ATC and Air Defence.

In addition there was a strong recommendation to consider air traffic as a joint civil/military system, for which emphasis was placed on the compatibility, coordination and complementary aspects of both component systems.

AUDIENCE REACTION

Interest was demonstrated by a consistently high attendance throughout the symposium. The usual questionnaire was issued requesting the partecipants viewpoints.

From the answers received it appeared that (a) the Symposium supported the theme very well; (b) the quality and relevance of the papers, sessions and questions were good. Further (c) from the comments obtained we can say that the meeting lived up to the expectation of the partecipants.

The organization of the Symposium was extremely good in all respects.

CONCLUDING REMARKS

It is evident from the symposium that avionics automation has developed more rapidly than ground systems in recent years.

ATC activity should enable procedures to be more compatible with the needs of modern aircraft, which is in accordance with the wishes of the ATC authorities. Consequently for air-to-ground communications, both Mode S and satellite-based systems shall each play an important through separate role.

In particular, satellite-based systems should further develop both in the fields of ADS (Automatic Dependent Surveillance) and also independent systems; that is space-based radar, for which a development strategy has yet to be decided.

The increase of air traffic density calls for more efficient management and control components. This requires automatic generation of optimum departure and arrival time sequences over extended areas, such as the whole of Western Europe, and the accurate control of individual flight from departure to arrival. A concept such as the Regional Organization of the Sequencing And Scheduling of Aircraft (ROSAS) for application in a Zone of Convergence constitutes a first step towards this objective.

For Air Traffic Management the systems will be able to find accurate data on the instantaneous and forecasted positions of aircraft, taking into account Meteo and AIS information, in an airspace organization based on Area Navigation procedures.

Finally, the human factor should play an increasingly important role both for space systems and for those of the ground, in which expert systems may better aid the operator in the decision making process.

RECOMMENDATIONS

The meeting papers, audience and round table discussion suggested research and development should be directed in the following fields:

Navigation

- Coverage requirements and international cooperation for satellite, integration function with ground equipment, system availability.

- MLS and ATC integration.

Communications

- Procedures and minimum system standardization

Surveillance

- Agreement for Automatic Dependent Surveillance

- Analysis for space-based radar system

Traffic Management

- Accurate 4-D control of aircraft

- Compatibility between different systems

- System fault-tolerance

- Factors connected with the role of the controller

Flight Management

- Avionic common standard

- Interoperability with ground system.

Concerted efforts such a Civil and Military Administration, Research Groups and Industry, will be performed to asses worlwide system improvements and in this direction the AGARD could be expected to play an important role.

APPENDIX-MEETING PROGRAMME

Tuesday 10th June 1986

KEYNOTE ADDRESS by Ir A. Vandenbroucke, Director General,Department of Air Traffic Safety,Brussels, BE

SESSION I – LOOKING TO THE FUTURE

Chairman Dr. A. Benoit, BE

11 - LE CHOIX DES SYSTEMES DE LA NAVIGATION AERIENNE CIVILE
O. Carel — Service Technique de la Navigation Aerienne, Paris, FR.

12 - THE NATURE OF THE FUTURE SYSTEMS: A US PERSPECTIVE ON FANS
S.B. Poritzky — System Studies and Cooperative Programs, FAA, Washington, DC, US.

13 - LA NAVIGATION AERIENNE A L'HORIZON DES ANNEES 2000: LE CONTROLE DU TRAFIC ET L'AVION
V. Vachiery — EUROCONTROL, Brussels, BE.

SESSION IIa – GLOBAL POSITIONING SYSTEM

Chairman Dr. M. Pelegrin, FR

21 - GPS: OVERVIEW AND PRESENT STATUS
P. Hartl — Institut fuer Navigation, Universitaet Stuggart, GE.

22 - INERTIE - GPS: UN MARIAGE DE RAISON.....A L'ESSAI
P. Loret, B. Capit — Sagem, Paris, FR.

23 - GPS AS THE SOLE MEANS NAVIGATION SYSTEM IN US NAVY AIRCRAFT
G. Lowenstein, J.Phanos — Naval Air Development Center, Warminter, PA, US.
E.E.Rish — Space and Naval Warfare Systems Command, Department of Navy, Washington, DC, US.

SESSION IIb – AUTOMATIC AIR/GROUND/AIR DATA LINK

Chairman Dr. M. Pelegrin, FR

24 - THE AVIATION INDUSTRY SATELLITE SYSTEM
R.A. Pickens — ARINC Research Corp. Annapolis, MD, US.

25 - POSSIBLE CONTRIBUTIONS FROM THE SSR MODE S DATA LINK, TO THE CONDUCT OF EFFICIENT AIRCRAFT OPERATIONS
M.E. Cox — EUROCONTROL, Brussels, BE.

Wednesday 11th June 1986

SESSION III – ADVANCED SURVEILLANCE RADARS

Chairman Prof. P. Murino, IT

31 - SPACE-BASED MULTIFUNCTION RADAR SYSTEMS: FUTURE TOOL FOR CIVILIAN AND MILITARY SURVEILLANCE
G. Galati — Dept. of Electronic, 2nd University of Rome, IT.
G. Losquadro — Selenia Spazio S.p.A., Rome, IT.

32 - MONOPULSE SECONDARY RADAR: PRACTICAL REALIZATION AND ACHIEVEMENTS: MODE S, THE ATC RADAR OF TOMORROW
F. Delille — Thomson-CSF, SDC, Meudon - La Foret, FR.

33 - A PRACTICAL EXAMPLE OF MOVING TARGET DETECTION PROGRAMMED PROCESSING FOR AN AIR TRAFFIC CONTROL RADAR WITH WEATHER CHANNEL
C. Bruno — Thomson-CSF, SDC, Meudon-La Foret, FR.

SESSION IV – ADVANCED LANDING SYSTEMS

Chairman Prof. G. Schaenzer, GE

41 - MICROWAVE LANDING SYSTEM (MLS) AREA NAVIGATION COMPUTED CENTERLINE EXPERIMENTS AND SYSTEM ACCURACY ANALYSIS IN AN RF ENVIRONMENT
J.Remer, B. Billmann — Federal Aviation Administration, TC, Atlantic City Airport, NJ, US.

42 - MLS: ITS TECHNICAL FEATURES AND OPERATIONAL CAPABILITIES
R. Seifert — Messerschmitt-Boelkow-Blohm GmbH, Muenchen, GE.

43 - ADVANCED ATC: AN AIRCRAFT PERSPECTIVE
L.Credenz, D.H. Williams, W.F.Howell, C.R.Spitzer — National Aeronautics and Space Administration, Langley Research Center, Hampton, Virginia, US.

Thursday 12th June 1986

SESSION V – AIR TRAFFIC MANAGEMENT-AUTOMATION-ADVANCED TMA
Chairman Prof. W. Hollister, US

51 - STRATEGIC CONTROL TO IMPROVE EFFICIENCY OF AIR TRAFFIC MANAGEMENT
L. Bianco — IASI, Consiglio Nazionale delle Ricerche, Roma, IT.

52 - A TIME-BASED CONCEPT FOR TERMINAL-AREA TRAFFIC MANAGEMENT
H. Herzberger, L.Tobias — NASA Ames Research Center, Moffett Field, CA, US.

53 - AIR TRAFFIC CONTROL AUTOMATION-PHILOSOPHY AND PROGRESS

PART 1 : V. Hunt — Advanced Automation Program Offic, FAA, Washington, DC, US.

PART II : L. Page — Systems Engineering Service FAA, Washington, DC, US.

54 - COMPUTER ASSISTED ARRIVAL SEQUENCING AND SCHEDULING WITH THE COMPAS SYSTEM
V. Voelckers — DFVLR, Institut fuer Flugfuehrung, Braunschweig, GE.

55 - NEXT GENERATION OF CONTROL TECHNIQUES IN ADVANCED TMA
A.Benoit, S. Swierstra — EUROCONTROL, Bruxelles, BE.

R. De Wispelaere — SV/ATS, Regie des Voies Aeriennes, Bruxelles, BE.

SESSION VI – FLIGHT MANAGEMENT AND OTHER ON-BOARD SYSTEMS
Chairman J.L. Hollington, UK

61 - EXPLOITING THE CAPABILITIES OF FLIGHT MANAGEMENT IN SOLVING THE AIRPORT ARRIVAL PROBLEM
J.F. Meredith — Smiths Industries/Aerospace and Defence Systems, Cheltenham, Glos, U.K.

62 - APPLICATION OF FLIGHT PERFORMANCE ADVISORY SYSTEMS TO US NAVY AIRCRAFT
M.J. Friedman, L.J.Cowles, R.C.Carson Jr — Naval Air Development Center, Warminster, PA, US.

64 - DESIGN CRITERIA FOR MULTI-LOOP FLIGHT CONTROL SYSTEMS
G.Schaenzer — Institut fuer Flugfuehrung der TU Braunschweig, GE.

65 - SOME EXPERIENCES IN INTEGRATING AVIONIC SYSTEMS ON THE CIVIL FLIGHT DECK
P.England, R.Harlow, N.Cooke — Royal Aircraft Establishment Flight Systems Department, Bedford, UK.

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Chairman Lt.Col. J.J. Coupez, BAF, BE

72 - SEMI-AUTOMATIC CROSS-CHECKING BETWEEN DIFFERENT COPIES OF THE SAME FLIGHT PLAN
S. Ratcliffe — Consultant to UK CAA, London, U.K.

73 - THE APPLICATION OF INTELLIGENT KNOWLEDGE BASED SYSTEMS TO AIR TRAFFIC CONTROL
W.S. Nicol — Civil Aviation Authority, London, UK.

G.C. Dean, A. Jackson — Royal Signal and Radar Establishment, Malvern, Worcs, UK.

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Conclusion
Closing Ceremony

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Landing systems
Radars
Global positioning systems (GPS)
4-D aircraft control
ATC/ATM automation

14. Abstract

The Guidance and Control Panel 42nd Symposium was held in Brussels, Belgium from 10 to 13 June 1986. The programme presented at the symposium is appended to this report, and the Conference Proceedings are published separately as CP 410.

This Advisory Report was prepared at the request of the Guidance and Control Panel of AGARD.

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